QUALITY + "CREATIVITY" = COMPLETE PROBLEM SOLVING

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SUMMARY

This paper presents a model for the effective integration of two problem-solving approaches: quality management and "creativity." Both approaches are useful at some point and neither can solve all problems. The effective problem solver should develop an understanding of, and a degree of comfort with, both. Adaption-Innovation Theory is used to help select the appropriate approach to a problem, to show how to deal with the diversity in individual problem solving styles, and to help guide the selection of problem solving techniques from quality management and "creativity."

KEY WORDS

innovation, leadership, teamwork

INTRODUCTION

Economic and social changes, globalization, and the development of new technologies create an environment where the rules of the game are changing rapidly. It is no longer sufficient for an organization to produce goods without defects—quality alone, however critical, is no longer a discriminator. According to Paul E. Mott (1972) organizational effectiveness requires three different, and sometimes mutually conflicting, characteristics.

- Organizations need to ensure "productivity" by diligently focusing on improving their processes to produce goods or services of high quality and at low cost in order to satisfy their clients.
- Organizations need "flexibility," that is, the capacity to react quickly to unforeseen or unpredictable events.
- To respond to the rapidly changing environment, organizations need to look beyond their current systems, problems, products, and services and actually look for problems or anticipate opportunities in order to generate new products or services that may not have been contemplated by their clients.

The first is the focus of quality management. The second and third are the focus of "creativity." While quality management or "creativity" may focus on one or another of the characteristics identified by Mott, each characteristic can profit from the use of techniques from both quality management and "creativity." Effective problem solving requires both quality management and "creativity" and we will offer a model to integrate the two.

We offer the following definitions for terms used in this paper:

- "*Creativity*:" The field seeking to find techniques to help people break old patterns of thinking in order to produce new and useful ideas. The term is used in quotes because there is no agreement in the literature of this field on a definition of creativity. The literature in the area focuses largely on techniques for stimulating out-of-the-box, or paradigm-breaking, thinking that tends to be equated, in this literature, with creativity.
- *Creativity*: The resolution and generation of novelty (Kirton 1994). Creativity, decision making, and problem solving all involve the generation and resolution of novelty. Today's problem solutions (resolution of novelty) are, or generate, new problems (novelty) that must in turn be resolved. This definition is egalitarian. Problem solving within existing paradigms is every bit as creative as problem solving outside the paradigms.
- *Quality management*: The field of study and practice seeking to develop and use tools, techniques, and processes for managing organizations through the use of data.
- *Tool*: Anything used to accomplish a task or purpose.
- *Technique*: A particular way of using a tool to accomplish something, e.g., solve a problem. Sticky notes with ideas (tool) are used to assist in brainstorming (technique) solutions to a problem. As we shall see later, brainstorming either stimulates, or simulates, innovative (out-of-the-box) thinking about a problem or possible solutions.
- *Process*: A systematic series of actions, in a set order, directed to some end. Brainstorming is a process in which various tools (sticky notes, flip charts, markers, etc.) are used in particular ways (techniques) in a specific order to generate ideas or options to solve a problem (the end or purpose). Note that brainstorming (like most other techniques) is both a technique and a process.

In quality management, brainstorming, fishbone diagrams, etc., are commonly referred to as tools. The definitions given here, and used in this paper, are intended to provide greater precision and clarity in the use of these terms.

There is a tendency for individuals to train in, and use, techniques with which they feel most comfortable. Thus, many toolkits are too small to enable optimum problem solving. "If all you have is a hammer, the whole world looks like a nail." There is great diversity in problems. There is diversity in approaches to problem solving (quality management and "creativity" to name only the two we discuss here). There is also diversity in preferred problem solving style and problem solving techniques. If we cannot effectively manage the diversities in approaches, preferred style, and problem solving techniques, we cannot effectively manage the diversity in problems. There is no "silver bullet." No approach, style, or technique will work every time for every problem, or for every part of a problem. A critical requirement for dealing effectively with diversities in approach, style, and technique is a means to enable groups to reach a shared understanding of the best general approach and style for a particular problem and the most effective technique to use for each element of a complex problem.

We present here a model based on Adaption-Innovation Theory that enables effective management of the diversity in problem solving approaches, in individuals' preferred problem solving styles, and in problem solving techniques from quality management and "creativity."

DIVERSITY IN APPROACH TO PROBLEM SOLVING

There are many approaches to problem solving but the two we will address are quality management and "creativity." The philosophy of quality management, as succinctly articulated by Dr. W. Edwards Deming (Deming 1986), implicitly embraces radical change and breakthrough improvement. Nonetheless, the focus of the field is on continuous incremental improvement within existing paradigms. Similarly, the "creativity" field recognizes the need for focusing down to a single solution to a problem and uses techniques, many similar to some quality management techniques, for focusing. Nonetheless, the strong and consistent focus of the "creativity" field is on developing techniques for generating out-of-the-box ideas and paradigm-breaking solutions. Out-of-the-box or paradigm-breaking thinking tends to be equated in this literature with creativity. As a consequence, anyone who doesn't think outside-the-box is viewed as uncreative. As we shall see shortly, half the human race has a preferred style in which they prefer to solve problems within the existing paradigms. To regard all such people as uncreative is elitist and unjustified.

The occasional need for more rapid and radical change than quality management typically generates is widely recognized and has led to reengineering as a problem solving approach (Hammer 1993). "Creativity" offers a source of paradigm-breaking ideas and options to support radical change. Once a number of paradigm-breaking problem solutions have been generated using "creativity" techniques, they must be evaluated and the "best" selected. Quality management has numerous techniques for evaluation and selection. Several creativity groups have developed a

complete problem solving process built around "creativity" techniques. One excellent example is "Creative Problem Solving" created by Scott Isaksen and the Creative Problem Solving Group, Buffalo. Once the best solution has been selected, quality management has many techniques to enable successful implementation, testing, and improvement of the new process, product, or service. Clearly, quality management and "creativity," while historically distinct, are complementary. If we can manage this diversity, we can increase the range of problems we can address, the number of solutions we consider, and the effectiveness of our solutions. To date, we have managed this diversity poorly. The quality management and "creativity" communities do not work in concert.

DIVERSITY IN PROBLEM SOLVING STYLE

Adaption-Innovation (A-I) Theory (Kirton 1994) posits that all individuals are creative and have a style in which they prefer to solve problems, make decisions, and be creative. These style preferences can be measured using the Kirton Adaption-Innovation Inventory (KAI) and lie on a normally distributed continuum approximately 100 points wide ranging from high adaption to high innovation. This preferred style does not correlate with *any* level measure such as: Success in problem solving, intelligence, rank, education, skill, experience, knowledge, etc.

Those scoring as more adaptive on the KAI prefer to solve problems using more structure, with more of this structure consensually agreed, than do the more innovative. The more adaptive are most comfortable working within and improving existing paradigms. They create and maintain the structures that enable organizations to function effectively. They will strive to provide solutions aimed at doing things "better." Their strength is in improvements (which may be large) to existing paradigms. Their weakness is that they may stay with the paradigm too long, e.g., by making better and better slide rules when people are beginning to use calculators, or by making better and better 14" disk drives when customers are switching to 8″ drives.

People scoring as more innovative prefer solving problems using less structure and are less concerned that the structure be consensually agreed than are those more adaptive. They may redefine the problem in ways that may not be readily understood by the more adaptive (or by others equally innovative), and tend to produce solutions aimed at doing things "differently." Different may or may not be better, and whether it is better may depend on who is judging. They provide the fresh thinking and new ideas that enable organizations to create new and radically different processes, products, and services. Their strength is their ability to break out of existing paradigms—to radically change existing structure. Their weakness is they may abandon the existing paradigms too soon while they still have useful life left in them. Paradigms exist because they work and because they are enabling. Switching to a new paradigm has a significant cost in, for example, retraining and retooling.

One's preference for amount of structure in problem solving is as much an innate part of each human being as eye color. No score is laudatory or pejorative any more than is eye color. The "right" amount of structure needed for any given problem depends on the problem. Therefore, groups with the greatest diversity in preferred styles will have the potential to deal successfully with the broadest range of problems. The difficulty is that people with different styles view structure very differently. This frequently leads to breakdowns in communication and even open conflict. What is needed is a shared understanding of A-I Theory, which states clearly that each and every style (amount of preferred structure) is uniquely valuable for dealing with some problems. Appreciation for the diversity in problems leads us to value the diversity in problem solving styles.

No one can solve problems successfully in the total absence of structure. Similarly, the more structure (e.g., rules or constraints) the more limited you are in solving the problem—too much structure and you probably cannot solve it. Language is a structure that enables you to think. The words in your language limit what you can think about. Like language, all structure is both enabling and limiting. The trick is to determine what is enough structure and what is too much. Since people with different styles see structure so differently, a group will be more effective at problem solving if there is a wide range of style preferences and if they reach agreement on the appropriate amount of structure through a dialog based on a sound understanding of A-I Theory.

The more innovative frequently speak disparagingly of the more adaptive as incremental or bureaucratic. What this disparagement overlooks is that "The essence of bureaucratic organization is the production of standardized, predictable, replicable performance by many different people and/or groups. It is bureaucracy that makes every Big Mac the same, that ensures that a federal tax return filed in Chicago is assessed the same way as one filed in Miami, and that allows you to pick up a phone, dial a few digits, and call any other phone in North America within seconds. And in the case of mass production, bureaucracy results in the lowest costs. How many people could afford hand-crafted automobiles, stoves, washing machine, televisions, and the plethora of consumer goods we've all come to expect (Bushe 1991)?" Structure is important.

The more adaptive frequently speak disparagingly of the more innovative as insensitive to others, unnecessarily disruptive, radical, and taking needless risks. Dr. Clayton M. Christensen in *The Innovator's Dilemma* (1997) points out how many well-managed companies with a committed focus on customer satisfaction have failed when faced with disruptive technological change. Christensen examines the computer disk drive industry and points out that many of the companies that ultimately failed had innovative people who foresaw the need for change. Some of these innovative people—when they could not interest their company in the new technology—left, started their own companies, and, along with other start-ups, ultimately took the market away from the large, well-managed, and well-established company they had left. Highly efficient, well-managed, low-cost producers with large established markets are frequently laid low by their inability to handle disruptive technological change. The ability to break structure is important.

We have seen that structure is important. We have also seen that the ability to break structure is important. Tight structure enables efficiencies of scale and mass production of quality products. However, the more a structure enables, the less a person enabled sees the limits created by the structure and the very success of the structure can lead to the failure of the company. Christensen (1997) notes that large successful companies continued to improve 14" disk drive systems in response to the stated needs of their customers. They produced drives with faster access times and greater storage density right up to the time when the producers of 8" drives took the market away from them. This same pattern was repeated for 5 1/4" drives and 3 1/2" drives. The very success of the structure these companies had created led to their downfall. It worked so well, that they saw no need to raise their heads out of the trench and look at the entire battlefield to find trends that might invalidate their structure. Loosening structure enables a broader definition of the problem, examination of a wider set of influences on the problem, and consideration of a wider range of possible solutions. The other side of this coin is that at some point the structure can become so loose that it is impossible to identify one optimal solution to the problem. Structure is both enabling and limiting but we frequently lose track of this fact and focus either on the enabling or limiting aspects of some particular structure.

"Structures are environments that affect how people behave. They channel effort and energy in a particular direction" (Bushe 1991). Appropriate structure and the ability to radically change that structure are *both* vital to healthy organizations. Whether more structure (within the paradigm) or less structure (outside the paradigm) is more appropriate for solving a problem *depends on the problem*. If you do not at least examine the appropriate amount of structure for solving a particular problem you have implicitly restricted the range of solutions available. The tendency is to use the amount of structure the organization has traditionally used or what you personally are comfortable with. To have a wide range of solutions available for consideration, you could assure your problem-solving group has people with a broad range of styles from highly adaptive to highly innovative. Lack of awareness of A-I Theory and the practical realities of organizations will produce such an ideal mix only by chance, and then rarely. Even when the mix is ideal for dealing with a specific problem, the mix will likely not be ideal for the next problem. The personal values of high adaptors and high innovators are so different that communication difficulties and even open conflict are commonplace in problem solving groups. Diverse problem solving styles are extremely important for effective problem solving, but they are not enough. Also needed is an understanding of A-I Theory with its insights into the enabling and limiting aspects of structure, the appropriate amount of structure for a problem, and the appropriate technique to use to either stimulate or simulate use of the correct amount of structure at a particular point in a problem.

We explicitly draw an analogy between the style of people who are relatively adaptive—seeking to solve problems through use of, and improvements to, existing paradigms—and the typical focus of quality management. Quality management typically operates on the premise that the existing paradigm is basically adequate but needs to be improved. It tends to focus on previous work and to move toward a clearly envisioned end. This approach utilizes relatively tight, but not rigid, structure.

We also draw an analogy between the style of people who are relatively innovative—preferring to focus on the problem and seek solutions within, across, or outside current paradigms—and the focus of the "creativity" field. "Creativity" focuses on out-of-the-box thinking and paradigm-breaking solutions. This approach posits that the focus should be on effectively solving the problem and not on the structure within which the problem "should" be solved. This approach also utilizes structure, but the structure is relatively loose.

DIVERSITY IN PROBLEM-SOLVING TECHNIQUES

There is great diversity in problem-solving techniques both within quality management (where they are referred to as tools) and within "creativity," and between quality management and "creativity." Within both areas, there are techniques for expanding out to identify options or ideas, and focusing down to find the best option or idea.

First, we will look briefly at techniques for expanding out. Consider brainstorming, a technique involving relatively little structure, used for generating a large number of ideas (expanding out) that can then be evaluated and the best selected (focusing down). For those more innovative, brainstorming *stimulates* their natural tendency to generate lots of, frequently out-of-the-box, ideas and paradigm-breaking solutions. For those more adaptive, brainstorming *simulates* a more innovative style of problem solving and helps them generate more ideas than is their want, and more ideas that are outside the paradigm. Note that the same technique serves, and is used differently by, people with different problem-solving styles.

"Creativity" offers a plethora of ways to enhance the number of ideas that are generated in a brainstorming session and particularly to increase the number that are new and radically different. The explicit goal of these techniques is to stimulate out-of-the-box thinking and paradigm-breaking ideas. Unfortunately, as the title "creativity" implies, the tendency in this field is to equate out-of-the-box thinking with creativity. Thus people who prefer to solve problems within the paradigm (roughly one-half the human race) tend to be regarded as second-class. It is our position, following Kirton (1994), that all problem solving is creative, whether within the paradigm or outside the paradigm. We also hold, again following Kirton (1994), that *the appropriateness of either style in solving a particular problem is determined exclusively by the nature of the problem*. The same is true for each part of a complex problem.

Let's look at "creativity" techniques used to enhance the output of brainstorming.

- Fantasizing: This technique involves "changing your point of view about an object by first eyeing it analytically and then by fantasizing." "Select a pencil and describe it from an analytical point of view. For example, it might be round, yellow, eight inches long, have a gray lead point and a half-worn eraser. Now fantasize. For example, I wish that it could do the following: write by itself; be eaten; never wear out; sharpen itself; write in several colors; and illuminate the darkness. Using this technique with a team of three or four diverse thinkers would likely generate, within 30 minutes, over 100 ideas from which some could be selected to form the basis for a new line of pencils" (Tanner, 1997).
- Provocation: "In lateral [divergent or out-of-the-box] thinking, the approach taken to test the side roads is to generate provocations. These are thoughts related to the issue being tackled, but we know them to be untrue. They are bizarre, impractical, provocative. The provocation is used for its forward effect—as a stepping stone to shift laterally out of standard, linear patterns of thinking. Think of the provocation as an unstable thought that has no judgment value per se but which, through 'movement,' leads to new ways to think about the problem" (Tanner 1997). Consider an organization striving to reduce costs in a particular production area. A provocation might be: reduce costs by spending more money. This could lead to a discussion of how spending more money in one small area would save much more money for the organization as a whole. An other example is that of an organization seeking ways to bring a product based on a radically new technology to market. A provocation might be: Give the breakthrough technology to our toughest competitor. This might stimulate a line of thought around how that competitor would bring the product to market (Tanner 1997).

The fundamental goal of these "creativity" techniques is to encourage paradigm-breaking ideas to help people break out of traditional, linear modes of thinking. The makers of computer disk drives could have profited greatly from some non-linear thinking during the period just before makers of smaller diameter disk drives took the market away from them and put them out of business. Dr. David Tanner (1997) provides examples of these and many other techniques and how they were used at Dupont to develop and market new products and save many millions of dollars. His book is both insightful and entertaining.

Techniques for focusing down allow individuals or groups to identify the one or few best of a long list of ideas or options. For people with a more adaptive problem solving style these techniques *stimulate* their natural inclination to use structure to focus on the most important items. For those more innovative, they *simulate* the more adaptive style of problem solving through the use of more structure. We observe a lot of similarity between many of the "creativity" techniques for focusing and the quality management techniques for focusing. We have not researched the origins of the techniques, we merely note the commonality.

Next, we'll look at two "creativity" techniques for focusing down.

- Musts/wants: This is one of many focusing tools. Basically the tool consists of defining a basis for dichotomizing a list of ideas or options in a way that appears useful as one step in focusing down to the one or few best. It is used as one of several steps in narrowing down a long list of ideas or options. In this case, ideas or options are sorted into: the most important ideas or options that must be considered; or ideas or options that you would like to consider. Other categories such as novel and useful can be substituted (Isaksen 1994). We are not aware of any quality management technique that sorts based on either of these pairs of criteria.

- ALUo: ALUo stands for *A*dvantages, *L*imitations, *U*nique qualities, and *o*vercoming the limitations of an idea or solution. Each idea or solution is evaluated against each category. The final category acts to improve on the idea or option by suggesting ways in which obvious limitations could be overcome. This technique provides a framework for comparing many different ideas and options on the way to selecting the one or few best (Isaksen 1994). It is closely related to the quality management technique called PMI or *P*lus, *M*inus, *I*nteresting. The basic difference between the two is the addition of a category in ALUo for ways of overcoming limitations.

It is important to note that a person's comfort with, and use of, any technique will differ depending on their personal style of problem solving. Expanding out techniques, whether from "creativity" or quality management will *stimulate* natural tendencies to generate many and diverse ideas among those more innovative. Those more adaptive will find that the techniques can help them *simulate* a more innovative, or less-structured) style of problem solving. Those more innovative will be more comfortable using these techniques than will those more adaptive. Those more adaptive will find that tools for focusing down (whether from quality management or "creativity") will *stimulate* their natural tendency to focus and use more structure while those more innovative will find that the same techniques *simulate* a more adaptive, more structured, style of problem solving. Those more adaptive will be more comfortable using focusing techniques than will the more innovative. A group aware of A-I Theory and of styles missing from their group may carefully select techniques for use at specific points in their problem solving process to enable them to simulate the missing styles.

We have seen that there is diversity in the approach to problem solving as illustrated by the quality management and "creativity" fields. We have noted that, problem solving style, as measured by the KAI, affects the degree of an individual's comfort with one technique or another. We also observed that there is a marked tendency for people to learn and apply the techniques with which they are most comfortable. As a result, all they have is a hammer, and the whole world looks like a nail. Different problems, and different parts of the same problem, may well profit from the use of either a "creativity" or quality management approach, i.e., less or more structure. Problems may be very complex. They may require one overall approach, but different elements may require different styles and different techniques. How can we effectively manage the diversity of problem solving approaches, styles, and techniques? We offer a model that we believe will resolve this problem. The model utilizes Adaption-Innovation Theory as:

- A basis for understanding and effective communication that will enable groups to reach consensus on the correct approach to solving the problem, or on the correct amount of structure for a given problem or element of a problem.
- A basis for arraying the problem solving techniques of quality management and "creativity" on a single continuum from most structure, to least structure as an aid in technique selection.

THE MODEL

We now present a new model to help integrate the fields of quality management and "creativity" and to enable you to consider the appropriate amount of structure needed at any particular phase of problem solving. Together, quality management and "creativity" enable more effective problem solving than either separately.

DIVERSITY IN APPROACH

Our model is built on the premise that consideration of the appropriate amount of structure for approaching a problem or dealing with a portion of a problem greatly enhances problem solving. All structure is both limiting and enabling. No single amount of structure can be appropriate for dealing with all problems. Diversities in approach to a problem (quality management or "creativity") are fundamentally differences in the amount of structure one chooses to use in solving the problem. The development of reengineering as a problem solving approach (Hammer 1993) is a recognition that there are times when classical quality management approaches involve too much structure to enable them to be used when available time is very short or the change needed is very large and radical. "Creativity" offers an approach that complements quality management. "Creativity" involves the use of a much looser structure to encourage out-of-the-box ideas and paradigm-breaking solutions that are more and more often needed as the rate of technological change increases. In turn, quality management offers more, and more varied, techniques for focusing on a solution, and techniques for collecting, analyzing, and using data to guide problem solving.

The first element of the model, then, is careful and thoughtful consideration of the approach (amount of structure) with which an organization chooses to deal with a problem. One may choose the general approach of quality management with its relatively tight structure or "creativity" with its much looser structure. In both fields one can find complete processes containing alternating expanding out and focusing down steps that generate ideas, evaluate the ideas, and select the best for implementation. The following is a representative, not exhaustive, list of factors that may be considered in choosing the appropriate approach.

- Is this a routine type of problem we have solved many times before?
- Do we want a solution within or outside the existing paradigms?
- How large and/or radical a change is required/desired.
- How critical is time in solving the problem?
- Are we familiar with both approaches or do we need consultants on one or both?
- How important is the problem and what resources are we willing to expend on it?
- What is the context? Who/what is impacted by the problem and possible solution and how?

We cannot stress too strongly that whichever basic approach is selected it is critical not to close the door to the other approach. Neither quality management nor "creativity," neither more structure nor less structure, can work all the time for all problems or even for all parts of a single problem.

DIVERSITY IN STYLE

Every human being has a preferred problem solving style. That is, they have a preference for the amount of structure to use when problem solving. Diversity in problem solving styles can lead to divergent views of the problem which can result in a far broader view of the problem and consideration of a much larger range of possible solutions. Style diversity can also result in such widely divergent views that communication is difficult and conflict can result.

The second element of the model is the use of A-I Theory to enable your organization or problem solving group to understand the importance of diversity in problem solving styles for effective problem solving. There is great diversity in problems and in the amount of structure appropriate for solving them. A-I Theory shows that all problem solving styles are essential for successful problem solving. A-I Theory also shows the breadth of understanding of the problem and the increased range of possible solutions that can result from diversity in styles. The result is increased understanding of, and appreciation for, the contribution of each member of the organization or problem solving group. This increased understanding and appreciation will enhance the communication essential to effective problem solving and remove an important potential source of conflict.

Careful consideration must also be given to the styles of the people who must make the determination to implement the group's solutions and the styles of the people who must carry out the implementation. People with different problem solving styles react differently to change. Understanding this difference can profoundly impact the effectiveness with which the need for a particular solution is communicated, the success with which the solution is implemented, and the amount of disruption accompanying the implementation.

DIVERSITY IN TECHNIQUES

Within quality management there is a great diversity in techniques. Individuals and organizations have developed problem solving processes, and methods for guiding the selection of the appropriate technique for a particular step in their overall process. One of the best and most comprehensive of these is an excellent book called *The Quality Toolbox* (Tague 1995). The problem has always been to guide people just starting in quality management in the selection of the right technique for each step in the quality improvement process. In the final analysis, technique selection is an art, not a science. Guidelines cannot be prescriptive formulas. There is simply too much variability between problems, contexts, and people for a cookbook approach with a recipe that fits every situation. We propose that every collection of problem solving techniques (toolkit) should include the techniques used in quality management as well as those used in the "creativity" field. The following are a representative, but non-exhaustive set of questions that may be considered in the selection of a technique.

- What is the problem solving process we are following and at what stage are we?
- Do we need to generate ideas or options (expand out) or select the best idea or option (focus down)? Do we want to increase or decrease structure at this step of the process?

- How time-critical is solving the problem?
- What resources do we have at our disposal?
- What is the level of experience/comfort of the group and/or facilitator with particular techniques?

The third element of the model is consideration of the appropriate amount of structure when choosing problem-solving techniques and evaluation of the impact of the problem-solving styles within the group on how these techniques will be regarded and used. To assist individuals and groups in making choices of appropriate techniques at any given point in the problem solving process, the Figure shows a representative set of techniques from quality management and "creativity" arrayed on a continuum from most structure to least structure. A-I Theory shows that the techniques involving more structure will *stimulate* the preferred style of those preferring more structure and they will *simulate* a more structured problem solving style for those preferring less structure. The techniques involving less structure will *stimulate* the preferred style of those preferring less structure and they will *simulate* a less structured approach to problem solving for those preferring more structure.

Moving from right to left in Table 1, the amount of structure increases. Moving from center to left, we focus down more and more narrowly on a single idea, option, solution, or piece of data. Moving from center to right, we expand outward by gathering more, and more paradigm-breaking, ideas and options. Expanding and focusing are two terms commonly used in quality management to describe respectively the generation and selection of ideas and options (Tague 1995).

We are not suggesting that you replace your current process or guidelines for selecting techniques with this continuum. We suggest you use the Figure to augment your current process in two ways. First, it shows a number of techniques from the "creativity" field with which those in quality management may not be familiar. Second, it keeps in the forefront of your thinking the following three critical points:

- Different amounts of structure are appropriate at different steps in any problem solving process.
- Different people prefer different amounts of structure in problem solving.
- People with different problem solving styles will tend to regard and use the same technique differently.

If your problem is to improve an existing process, to make within-the-paradigm changes and modifications (however large), then quality management has techniques to do the job. If your task is developing a breakthrough product to knock the socks off the competition, then you will find the appropriate techniques in the "creativity" literature. But there is more to this story. If in your process improvement project you fail to use some of the techniques of "creativity," you are limiting yourself to a relatively narrow set of choices and greatly reducing chances of coming up with a breakthrough improvement that will make the process dramatically cheaper and more efficient. You slam the door on the possibility of creating the next blockbuster product.

If your problem is to develop the next blockbuster product, or to reduce waste in a process by a factor of ten more than you have ever achieved in any year in the past, then "creativity" techniques can help. Once you have some super-sounding ideas and options, both quality management and "creativity" have techniques for analyzing these ideas and options and choosing the "best." Once you have selected a solution, quality management provides the techniques that allow you to do a test run on your new product, process, etc. and generate and analyze data on how well it works in practice. If there are problems in implementation, a mixture of quality management and "creativity" techniques may enable a breakthrough. Quality management techniques and "creativity" techniques complement each other. Both should hold honored places in your problem solving toolkit.

A thorough understanding of A-I Theory is the foundation on which an organization can deal effectively with the diversities in problem solving approaches, styles, and techniques. Knowledge of the enabling and limiting nature of structure can add a critical new dimension to your problem solving and greatly enhance your success. Awareness that people prefer different amounts of structure in problem solving, and understanding that all styles are useful and no one style is appropriate for every problem or every stage of a problem, helps groups recognize the value of diversity in problem solving styles and removes a major source of miscommunication and conflict. Knowing that different amounts of structure are appropriate for different problems and for different parts of the same problem enables the group to reach consensus on the right amount of structure with less conflict and consider a wider range of approaches, styles, and possible solutions. The result is fewer communication problems, less conflict, and more effective problem solving.

A PROBLEM SOLVING PROCESS USING THE MODEL

We offer the following questions that you *might* address using our model in conjunction with whatever problem solving and technique-selection processes you are currently using. Note that this list is neither exhaustive nor prescriptive. There is far too much variation in problems, contexts, problem solvers, and techniques to permit a cookbook approach to problem solving. The questions based on our model are in italics.

1. What is the context of the problem? Who/what is impacted by the problem or possible solution? How?
2. *What are the problem solving styles of the individuals who must make the decision to implement our solution or who must carry out the implementation?*
3. *What approach do we choose for this problem? Do we want to consider only solutions within the paradigm? Only outside the paradigm? Both?*
4. *If the style of the solution we chose differs from the styles determined in question 2., will we need to make special plans for "selling" the solution?*
5. *What are the preferred problem solving styles of the people in our group?*
6. *Do we have the appropriate mix of problem solving styles in our group? Do we need to add members? Do we need to be prepared to use the appropriate techniques to simulate the missing styles?*
7. What resources do we have to expend on the problem and the solution?
8. How important is the problem?
9. What is our problem solving model?
10. At what stage of our problem solving model are we?
11. What possible techniques are suggested by our technique-selection model (e.g., Tague 1995)?
12. *What is the appropriate amount of structure for this stage of the problem solving process?*
13. *Do we need to use techniques to simulate styles missing from our group?*
14. Should we be expanding out or focusing down?
15. *For the amount of structure we selected, what techniques from the Figure are appropriate?*
16. *Which technique (from quality management or "creativity") do we choose to use?*
17. Repeat questions 10. through 16. as needed to arrive at the "best" solution.
18. Is our "best" solution consistent with the choice we made in question 3?

Many such lists could be generated. This example is offered to illustrate how our model can be used to enhance, not replace, whatever processes you are currently using.

CONCLUSION

Paul Plsek (1997) argued eloquently that quality management needs "creativity" techniques. We have added to his work by noting that quality management techniques also complement "creativity" techniques and by noting the importance of considering the amount of structure appropriate to the entire problem and to each step in the problem solving process.

We have offered a model that provides for careful management of diversity in approaches to the problem, in individual problem solving styles, and in problem solving techniques. This model is not intended to replace models you are currently using for problem solving or technique selection. It is offered to complement your current models. George A. Box, a prominent American statistician, was said to have remarked: "All models are flawed; some are useful." We believe that you will find this model useful. We believe our model will enable your group or organization to deal more effectively with diversity of approach, preferred style, and techniques. You will, as a result, be more effective problem solvers.

We have strongly emphasized A-I Theory with its insights into problem solving style and the importance of deliberately selecting the appropriate amount of structure for solving each problem. Based on our experience, this theory is a singularly rich source of insight into individual, group, and organization problem solving. Understanding the theory will remove a major source of miscommunication and even conflict in problem solving groups at every level of an organization. Understanding and effective use of this theory will make you and your organization much more effective at solving problems.

Table 1. Quality management and "creativity" techniques arrayed on a continuum indicating approximate relative amounts of structure.

Evaluation Matrix–C	Multivoting–Q	Brainstorming–Q/C	Guided Fantasy–C
Process Capability Studies–Q	Nominal Group Technique–Q	Nominal Group Technique–Q	Provocation Techniques–C
Control Chart–Q	Affinity Diagram–Q	Brainwriting–Q/C	Metaphoric Thinking–C
Check Sheet–Q	Is-Is Not Matrix–Q	Mind Mapping–C	Capture/Interpret Dreams–C
Flowchart–Q	Highlighting–C	Flowchart–Q	Point of View–C
Tree Diagram–Q	Tree Diagram–Q	Why-Why Diagram–Q	Visually Identifying Relationships–C
Cost of Quality Analysis–Q	Fishbone Diagram–Q	Fishbone Diagram–Q	(Many, Many More Techniques and Processes Designed to Help Break Out of Old Ways of Thinking)–C
Graph–Q	HITS–C	SCAMPER–C	
Design of Experiments–Q	Musts/Wants–C	Six Thinking Hats–C	
Histogram–Q	Criteria–C		
Operational Definitions–Q	Matrix Diagram–Q		
Pareto Analysis–Q	Short-Medium-Long–C		
Decision Matrix–Q			
Paired Comparison Analysis–Q			

MOST STRUCTURE MODERATE STRUCTURE LIMITED STRUCTURE LEAST STRUCTURE

DECREASING STRUCTURE>>>>>>>> <<<<<<<<INCREASING STRUCTURE

<<<<<<<<FOCUSING EXPANDING>>>>>>>>

<<<<<<<<REDUCING NUMBER OF IDEAS/OPTIONS INCREASING NUMBER OF IDEAS/OPTIONS>>>>>>>>

NOTE:
1. Q means quality management technique. C means "creativity" technique.
2. This list of techniques is representative, not exhaustive.
3. Position on the scale shows relative structure *stimulated* or *simulated* by the techniques.
4. Virtually all the techniques are processes.
5. Brief descriptions of the techniques are given in the Appendix.

APPENDIX

Brief Descriptions of Techniques Listed in the Table

Affinity Diagram: Organizes large numbers of ideas or options into natural relationships. Q
Brainstorming: Process for generating large numbers of ideas in a short time. Q/C
Brainwriting: A nonverbal variation of brainstorming. Q/C
Capture/Interpret Dreams: Making notes on dreams and interpreting them in terms of a problem. C
Check Sheet: A structured, usually custom-made, form for collecting data. Q
Control Chart: A graph used to analyze data from a process to study its variation over time. Q
Cost of Quality Analysis: Use of a flowchart to identify costs resulting from poor quality. Q
Criteria: Technique for developing standards for evaluating ideas or options. Used by Creative Problem Solving Group-Buffalo (CPS-B). C
Decision Matrix: Ranks a list of choices based on selected criteria. Q
Design of Experiments: Process for making selected changes to a process to determine the output response. Q
Evaluation Matrix: Variation of the decision matrix. (Q) Used by CPS-B. C
Fishbone Diagram: Diagram used to structure a brainstorming session to identify causes of a problem. Q
Flowchart: A picture of the steps of a process in their actual order. There are several variations. Can be used to guide brainstorming to design new processes. Q
Graph: Visual display of numerical data designed to provide insight into the meaning of the data. Q
Guided Fantasy: Techniques for fantasizing about a problem. Encourages paradigm-breaking thinking. C
Highlighting: Variation of affinity diagram used by CPS-B. C
Histogram: A bar graph used to show how often particular values occur in a set of numerical data. Q
HITS: Variation of multivoting. (Q) Used by CPS-B. C
Is-Is Not Matrix: Structured process to identify causes of a particular problem. Used by Kepner-Tregoe. Q
Matrix Diagram: Graphic display of relationships between up to four groups of data. Q
Metaphoric Thinking: Linking a problem to something in a totally unrelated field to find breakthrough ideas. C

Mind Mapping: Places core subject in the center of a page as a guide to finding multiple ideas that branch out from the subject. Acts as an aid to brainstorming. C

Multivoting: Evaluation process for selecting the best ideas from a brainstorming session. Q

Musts/Wants: A process for ranking options or ideas. Used by CPS-B. C

Nominal Group Technique: A focusing technique to narrow down ideas and options, frequently from brainstorming. Also used as a variation of brainstorming. Q

Operational Definitions: Provide communicable, shared meaning of key words, concepts, or specifications. Used extensively in assuring everyone involved knows what to measure in a process and how. Q

Paired Comparison Analysis: Process for ranking a group of choices by comparing each to each of the others. Q

Pareto Analysis: Use of a bar graph, where heights represent some important variable such as cost of re-work, to separate the significant few from the trivial many areas for process improvement. Q

Point of View: Various techniques designed to make you think about a problem in a totally different way. C

Process Capability Studies: Used to tell if a production process can meet customer specifications. Q

Provocations: Use of stimuli that are bizarre, impractical, and provocative to encourage lateral thinking. C

SCAMPER: Acronym for a series of questions to enhance brainstorming sessions. C

Six Thinking Hats: Focused process for thinking including time for innovative thinking. By Edward de Bono. C

Short-Medium-Long: Process for generating a timeline for implementing a problem solution. C

Tree Diagram: Technique to identify specific assignable actions to implement a problem solution. Q

Visually Identifying Relationships: Uses pictures to stimulate paradigm-breaking thinking. Used by CPS-B. C

Why-Why Diagram): Variation of tree diagram used to identify causes of a problem. Q

C: "creativity" technique; Q: quality management technique.

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